TECHNICAL CREATIVITY AND THE FUTURE OF ENGINEERING EDUCATION

With the complexity surrounding every engineering project mounting as natural resources dwindle, the world population increases, and the global infrastructure and economy grow ever more intertwined, the creativity and innovation necessary to address the big issues facing civilization - maintaining the infrastructure; providing food, water, shelter, and power to the population; and growing sustainably and safely - will only increase in importance.

The Business Case for Creativity

The world has grown interconnected and complex. In this new, interdependent era, local problems can quickly become regional or even international. Global energy use, meanwhile, is increasing exponentially – faster even than population growth. The world population in 1940, at just over 2 billion, consumed 2.5 gigatons of oil equivalent of power (EPRI 1999). In 1999, a population of 6 billion consumed over 11 gigatons – an increase in power over population of almost 2 to 1. The U.S. Department of Energy (DOE) reports that over the next two decades "*growth in U.S. energy consumption will increasingly outpace U.S. energy production*". If this trend continues America will develop "*increased dependency on foreign powers that do not always have America's interests at heart*".

Traffic congestion costs the 75 largest urban areas almost $70 billion annually. Since 1970, the number of registered vehicles in the United States has nearly doubled while road capacity has increased only 6 percent. If this trend continues, by 2020, our country will experience "*trucks that can't make deliveries on time, people who can't get to or from work, air quality that continues to deteriorate as commerce suffers and our over-all geopolitical position weakens because we are forced to become ever more dependent on foreign oil*". Meanwhile, the amount of arable land available worldwide is dwindling at a steady rate, as an estimated 3.7 billion acres of topsoil are eroded each year. These concerns affect all citizens of the world –but who is going to address them and on what terms?

The recent outcome-based criteria developed by the Accreditation Board for Engineering and Technology (ABET) stipulate that graduates develop:

- An ability to identify, formulate, and solve engineering problems; and
- The broad education necessary to understand the impact of engineering solutions in a global and societal context.

Nowhere in the eleven ABET outcomes criteria, however, is there reference to creativity or the need to teach creativity to students. What kind of engineering problems are future engineers going to solve? If they are to solve the critical issues surrounding the infrastructure, economic development, and the natural environment, then new and innovative solutions will be demanded. To meet the exigencies of our greatly changed world, we must rethink and reengineer infrastructure system life cycles to serve their original purposes under new conditions, such as globalization, deregulation, telecommunications intensity, and increased customer requirements. If students (and future engineers) are to understand the broad impact of engineering solutions in a global context –as called for by ABET – they will be forced to grapple with variables and contingencies that will continue to evolve. How will civil engineers of the future learn to approach and solve these problems? Creatively, of course.

You Can't Even Teach Creativity, Can You?

Without training in the fundamentals of creativity, it is little wonder that so few engineers are viewed as creative professionals and that only 3% of the population associate "*creative*" with engineering. As with leadership, it is a far too common a notion that creativity is an inherent gift that one either does or does not possess. Not only can creativity be taught, it is taught effectively at all levels of education, from kindergarten to graduate school. Some engineering professors make creativity an explicit component of their courses. A select few programs such as Olin College and Worcester Polytechnic Institute even go to great lengths to cultivate creativity throughout their curricula. On the whole, however, civil engineering programs are not intentional about developing creativity.

Most any process can be improved, and since creativity is essentially a process, it too can be studied, tracked, and improved. There are tests and metrics that can help measure and gauge creativity, but the experts agree that to develop creativity you must learn to flex and reflex your creativity muscles. This process is often enhanced though the use of creativity tools such as brainstorming and idea notebooks. Brainstorming is a two-step process where ideas are first generated without constraint, and then critiqued using criteria such as practicality or applicability to the problem domain. Many variations exist, including using computer programs such as Ideafisher. But again, you must use it or lose it. If one does not consistently practice creativity techniques, like any machine or muscle, they will grow rusty and stiff. Yet like riding a bicycle, once you learn how to be creative, you will have a hard time not remembering – or taking advantage of – the basics.

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